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A Study On Gas Desorption From Inductively Coupled Plasma Chamber Wall By Optical Emission Spectroscopy Method

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Abstract: In nitriding stainless steel experiments in rf inductively coupled plasma chamber, optical emission spectroscopy (OES) measurements were carried out within the visible range. The gases used for these experiments were pure nitrogen and hydrogen, while the emission was dominated by nitrogen species and almost independent of their composition ratios, provided that the other discharge conditions remained unchanged. The gas desorbed from both the inner wall of vacuum chamber and substrate-holder surface produced significant influence on the emission intensities and even caused the discharge to be unstable to some extent. To reduce the effect of desorption on discharge, a series of experiments were carried out namely, without any conditioning, zero time-gap conditioning, and 1 hour time-gap conditioning prior to nitriding SS (stainless steel) 304 samples. The characteristics of the plasma, observed by OES method, at different conditioning conditions and their effects on the quality of nitrided layers will be reported in details.

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Real-Time Feedback Control of Plasma Density in Inductively Coupled Plasmas

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The real-time feedback control has the potential to enhance the process reliability of VLSI fabrication [1]. Most of the studies on real-time feedback control of plasma processing tools were performed on RIE systems[1]. Optical emission spectroscopy was usually employed to serve as the *in situ* measurements. For inductively coupled plasmas (ICP), a controller based on response surface methodology was designed to control plasma parameters such as species densities, fluxes and energies[2] by employing numerical plasma simulations. The purpose of this study is to demonstrate experimentally the real-time feedback control of plasma density in an ICP. The sensor of the controller was a 36 GHz heterodyne interferometer which measures the line-averaged plasma density. The 13.56 MHz RF power driven the ICP antenna was used as the actuator while the gas pressure was varied to serve as a disturbance causing the plasma density deviates from the set point. To compensate the effect of the disturbance, the ICP RF power was varied accordingly. For this proof-of-principle experiment, the PID algorithm was chosen for the controller. A forward controller with a specific trajectory planning was also embedded into the system to smooth out the overshoot and oscillations of electron density when a sudden change of RF power occurs, such as power on or off. The experiment was conducted in an ICP reactor, which used a planar type coil and had a chamber diameter of 40 cm and a height of 20 cm. The feed gas was Argon and the flow rate was kept at 15 sccm during the experiment. The heterodyne interferometer was temperature controlled to enhance its stability on phase measurement to within 1°. The experimental results show that the electron density can be maintained at the set point value with a maximum deviation of 3%. The forward controller also successfully eliminated the overshoot at the power on period. In addition, the sampling frequency which strongly affects the stability of the feedback system, was also examined. An optimum value of 10 Hz was found for the particular setup used in this study.

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